Chapter 8 Miscellaneous Construction Contents

Chapter 8 Miscellaneous Construction

8-0 Introduction

Although many items of construction in this chapter are specialized, procedures for sampling materials, documenting construction, and requiring that work be done in accordance with the specifications is not different from other types of highway construction work.

Federal, state and local water quality regulations prohibit sediment and other pollutants associated with construction activity from impacting air and water quality. All projects must comply with these laws and the required permits. WSDOT creates Temporary Erosion and Sediment Control (TESC) plans to prevent erosion and any damage to the site, adjacent properties, and the environment. Section 8-01 of the *Standard Specifications* covers the requirements for controlling erosion and water pollution on projects. Applicable provisions are included in the contract and must be enforced by construction staff to ensure effective erosion prevention and water quality protection.

The National Pollutant Discharge Elimination System (NPDES) Construction Stormwater General Permit is one of the most common permits on WSDOT projects. It requires erosion prevention when vegetation is removed, when soil is disturbed, or when water flow has the potential to cause erosion. In addition to the required TESC planning, the NPDES permit requires site inspections, water quality monitoring (both turbidity and pH), and record keeping.

It is important to partner with environmental agencies during construction. Early, open communication sets up a good working relationship that may prove invaluable later on if problems occur. Permit requirements normally require notification to environmental agencies prior to conducting construction activities. On some projects it may be advisable to invite representatives from regulatory agencies to part of the preconstruction meeting when environmental issues are discussed.

When working around sensitive areas, applicable permits are typically attached to the contract as appendices. These permits must be carefully reviewed to ensure that, among other things, the Temporary Erosion and Sediment Control (TESC) plan meets permit requirements. It is important to remember these permits are sometimes obtained after the main design work was done. If the original TESC plan does not meet permit requirements, the plan must be modified with the assistance of the Region Environmental Office.

8-1 Erosion Control

8-1.1 TESC Planning and Implementation

A TESC plan consists of a narrative document and plan sheets. The narrative document includes an analysis of erosion risk and a list of *Standard Specifications*, *General Special Provisions* (GSPs), and special provisions used to mitigate the risk. The plan sheets show the locations of BMPs and other features such as topography and location of sensitive areas for multiple project stages. Chapter 6 of the *Highway Runoff Manual* M31-16 provides guidance on creating thorough TESC plans. Appendix 6A describes all erosion control best management practices (BMPs). Contact Region Environmental or the Statewide Erosion Control Coordinator for more information.

WSDOT develops the TESC plan and tries to account for all inherent risks on each site and plan to minimize these risks through the use of design, procedural, and physical BMPs. The effectiveness of TESC plans will vary based on how well designers assessed risks and selected contractually enforceable tools for addressing those risks. Unpredictable elements such as the weather also impact effectiveness of the TESC plan. Although we try, it is truly impossible to account for all risks associated with a project before construction begins.

When constructing the project, there may be times when it is necessary to exceed the maximum acreage exposure limits allowed by *Standard Specification* 8-01.3(1). If the Engineer grants the Contractor's request to exceed these limits, the Contractor must provide to the Engineer a revised plan, commensurate with the scope and risk of the variance proposed, stating what measures will be used to protect the project from erosion damage, how water quality and sensitive areas will be protected, and include the schedule of methods employed to regain adherence to 8-01.3(1). The Construction Stormwater General Permit (NPDES) prohibits the Engineer from increasing the time periods required in 8-01.3(1) for covering erodible soil that is not being worked.

The Contractor can either adopt WSDOT's TESC plan or provide suggested revisions. These suggestions may lead to additional costs, but if they properly identify the risks that we missed or suggest more practical solutions, those ideas should be adopted. However, some suggestions weaken plans and put WSDOT at greater risk of problems. Such proposals should be rejected. Encourage the contractor to help develop solutions that are compatible with their construction activities. Getting everyone involved early in the process will help you come up with effective solutions that can be agreed upon by everyone.

It is important to clearly understand the TESC plans prior to construction. The actual site conditions may not match those described in the original plan due to development in the area, changed construction dates, and inaccuracies in the original plan. Newly paved areas or housing developments located up gradient from the project site may increase surface water flows to the site. An accurate evaluation of current site conditions is essential for preventing erosion.

When conducting an initial evaluation, the inspector should walk through the site with the TESC plan in hand. If available, the designer should go along on the walk through. It is important to verify the current site conditions and determine whether any plan changes are necessary. Mark any needed changes on the plan sheets so that necessary changes can later be shown to the contractor.

Some of the most important factors leading to erosion control problems include: offsite runon, groundwater, unstable slopes, poor soils, and exposing too much soil during the wet season. **Therefore, the responsiveness of construction staff to changing conditions is the most important determining factor in whether or not the plan is effective.**

Knowledge of soil types in the project area is quite important. If erodible soils are present, special consideration must be given to reducing erosion when these materials are encountered in cuts or used in embankment construction on the project. If problems are encountered during construction, contact Region Environmental staff or Geotechnical staff for assistance.

Frequently, infiltration can be used when other BMPs fail to make site runoff meet water quality requirements and to reduce stormwater volumes. Infiltration should be considered whenever conditions allow. On sites with highly permeable soils and large undisturbed areas, infiltration should be used as one of the main storm water management BMPs. When no runoff leaves the site the possibility of water quality exceedence is eliminated and smaller volumes of stormwater reduce the overall potential for erosion.

As a project progresses, new risks emerge and must be addressed in order for the TESC plan to remain effective. Prevention is better, cheaper, and easier than repair or mitigation after a plan fails. Many problems can be prevented in the initial stages of construction if the Contractor protects the roadway as work progresses. In the long run, poor construction practices can cost the contractor additional money to correct the damage.

By maintaining an effective TESC plan, WSDOT will save money, time, and prevent environmental problems. Should an environmental non-compliance event occur, i.e. an action not in compliance with environmental standards, permits, or laws during construction refer to Section 1-2.2K(1) for the appropriate notification and corrective action procedures.

Upon project completion and final stabilization, most temporary BMPs are removed and removal is paid for using the force account item when it is included in the contract. It is the responsibility of the inspector to ensure that the contractor removes temporary BMPs in such a way that we do not impact water quality or increase the potential for erosion. Some temporary BMPs, such as inlet protection, must be removed or they may cause problems in the function of the facility. Others, such as wattles or compost socks, may be allowed to remain until they biodegrade if they are serving a useful purpose and do not pose an impediment to safety or function. However, some BMPs such as silt fence may need to remain in place and be removed after the need for them has passed, even if the duration extends beyond contract completion. Inspectors must determine when the site is adequately stabilized and the temporary BMPs can be removed. The Project engineer may need to coordinate with State Maintenance forces to arrange for silt fence or other BMP removal occurring after the contract is completed.

8-1.2 TESC Inspections

The contractor must identify their certified Erosion and Sediment Control (ESC) Lead for the project and include the ESC Lead on the Emergency Contact List. The ESC Lead must have, for the life of the contract, a current Certificate of Training in Construction Erosion and Sediment Control from a course approved by the Washington State Department of Ecology. Information on approved training can be obtained at: http://www.ecy.wa.gov/programs/wq/stormwater/cescl.htm.

The Contractor's ESC lead is obligated to perform erosion control inspections using a standard WSDOT form. *Standard Specification* 8-01.3(1)B provides additional guidance on site inspections including the standard form number. Inspections completed using the form meet NPDES Construction Stormwater General Permit requirements. WSDOT staff should verify the Contractor is inspecting the site, maintaining records, and showing plan revisions. WSDOT must keep a copy of all inspection reports on-site in a Site Log Book in order to be in compliance with the NPDES requirements.

If WSDOT can identify potential erosion areas early, we can prevent problems such as stop work orders and fines from Ecology, construction delays, and unfavorable publicity. Site inspections allow us to verify that the Contractor is implementing the plan and that it is working effectively. You should walk through the site with the TESC plan in hand to evaluate whether BMPs were installed as specified on the plan drawings. You may need to assist the Contractor with identifying appropriate locations to ensure the site is always prepared for a storm. Inspections must also be made during storm events to evaluate how well BMPs are performing.

The effectiveness of BMPs must be evaluated in the field. If installed BMPs are ineffective, replacement BMPs must be selected and installed. If the quality of installation or lack of maintenance is responsible for a failure, the contractor should repair the BMPs at no cost to WSDOT. If the failure is a result of faulty BMP selection, we must identify a new BMP. Any changes to BMPs in the field must be recorded or drawn onto the TESC plan sheets and documented on the site inspection form. For recommended erosion prevention practices see Chapter 6 of the *Highway Runoff Manual* M31-16. For site-specific recommendations, contact Region Environmental or Environmental Services Erosion Control Coordinator.

Everyone on the construction site should know what to do when an environmental agency representative visits the site. The Contractor's ESC Lead is trained to direct the agency representative to the project engineer or the inspector delegated in charge of erosion issues. All Contractors working on the site must know who is in charge of erosion control for WSDOT. Contractors should be directed

to help resource agency staff locate this person. When contractors direct resource agency staff to the person in charge problems are solved more quickly and a positive image is established. If there is a general difference of opinion with an agency representative, the issue should be immediately elevated to the Project Engineer, or Regional Engineering or Environmental Staff who can help develop an effective solution.

8-1.3 Water Quality Monitoring

Water quality monitoring is a permit requirement on many WSDOT construction projects. Sampling frequency and location, and compliance triggers vary, depending on the type of permit issued. WSDOT staff are responsible for collecting water quality samples, and to meet this requirement, WSDOT has developed protocols in Chapter 6 of the *Highway Runoff Manual* (M31-16) that dictate when, where, and how these samples are collected. Turbidity, defined as the visual clarity of the water, is a measure of how much mud is in construction site runoff water, and is the most common pollutant for which WSDOT is required to sample. The second most common pollutant is water pH, a measure of the acidity or alkalinity of water, and is measured to determine if the runoff is too acidic or alkaline. Water that is too acidic or alkaline will kill fish. Construction activities involving concrete may alter the pH of stormwater in a manner that will harm fish, if the runoff is not treated.

Projects that involve in-water work, and are issued a 401 Certification (certification from the state that the proposed project will meet state water quality standards and other aquatic protection regulations) are required to collect both upstream and downstream samples for turbidity, and for pH if concrete work is occurring. The monitoring protocols in Chapter 6 of the *Highway Runoff Manual* must be followed. Upstream sample values are compared to downstream sample values to verify that water quality standards are achieved. WAC 173-201A, defines the required standards as follows:

> Turbidity shall not exceed 5 nephelometric turbidity units (NTU) over background turbidity when background turbidity is 50 NTU or less, or more than a 10 percent increase in turbidity when background turbidity is more than 50 NTU.
>
> pH shall be within the range of 6.5 to 8.5 with a human-caused variation within the range of less than 0.2-0.5 units, depending on the class of the waterbody.

The NPDES General Construction permit requires that all projects with greater than 5 acres of soil disturbance sample for turbidity. After October 1, 2008, all projects with greater than 1 acre of soil disturbance will be required to sample for turbidity. Samples must be collected at all outfalls (locations where construction stormwater or authorized non-stormwater) discharges off-site or into state waters). These samples are intended to verify that a TESC plan is well implemented and that BMPs are working effectively. Outfall sample values must be compared to benchmark values for turbidity, and pH if applicable, to verify that WSDOT is in compliance with the permit. Compliance with benchmark values presumes compliance with state water quality standards. If samples exceed benchmark values, adaptive management must be performed as described in Chapter 6 (Section 6-8) of the *Highway Runoff Manual*.

Samples for determining pH must be collected on projects with greater than 1 acre of soil disturbance if more than 1000 cubic yards of concrete is curing simultaneously during a less than 30 day period, if more than 1000 cubic yards of recycled concrete is on site, or if cement or kiln dust amended soils are present. Process water or wastewater (nonstormwater) that is generated on-site, including slurry and water generated during concrete grinding, rubblizing, washout, and hydrodemolition activities, cannot be discharged to waters of the state under the NPDES General Construction Permit. Offsite disposal of concrete process water must be in accordance with the *Standard Specifications* or contract provisions. Under limited circumstances, infiltration of process water may be acceptable. As standards for dealing with process water are still evolving, contact region environmental and Headquarters Stormwater and Watershed Program to determine if infiltration is an acceptable option.

Sometimes neighboring sites or projects cause increases in turbidity that can be falsely blamed on WSDOT. It is important to document such events and report them so that we are not unfairly blamed for other people's water quality problems.

We are required by law to report any water quality exceedence to the Department of Ecology. WSDOT has developed Environmental Compliance Assurance Procedures (ECAP) that must be implemented immediately to report any permit non-compliance. These procedures are contained in Section 1-2.2K(1) of this manual.

It is important that environmental agencies hear about a problem from us as soon as it happens rather than from the public or by discovering it themselves. Enforcement actions rarely occur when projects self-report non-compliance events. Self-reporting sends a message that we are making a good faith effort and have nothing to hide. Not reporting suggests that we are covering up a problem or simply do not care.

As part of ECAP, all certified Contractor ESC Leads have been trained to notify the project engineer immediately upon discovery of a water quality exceedence or situation that may lead to a exceedence. Nevertheless, it is our responsibility to be watching ourselves. If a problem is identified, we should notify the project engineer and immediately take all measures possible to reduce impacts of the problem. The project engineer or a designee reports non-compliance events to resource agencies.

8-1.4 Record Keeping

The NPDES Construction Stormwater General Permit requires that water quality data be submitted monthly for all projects greater than 5 acres of soil disturbance after October 1, 2006. HQ Environmental Services Office will batch send data to Ecology monthly via the Water Quality Monitoring database. Therefore, all projects must enter water quality data into the database.

WSDOT is also required to maintain a Site Log Book for each project that is to remain on-site. This Log Book must contain copies of all site inspection reports performed by the Contractor's ESC Lead, copies of water quality monitoring data (collected by WSDOT), and any information pertaining to installation and maintenance of Best Management Practices (BMPs).

WSDOT must retain documentation of compliance with permit requirements during the life of the contract and for a minimum of three years following the termination of the contract. This includes: the Site Log Book, water quality monitoring results, inspection reports, TESC plans and any other documentation.

8-1.5 Final Stabilization

The permanent protection of earth cut and fill slopes should be accomplished as soon as possible. When provided in the contract, topsoil should be evenly placed on the slopes at the specified depth for areas to be seeded. After placement of top soil, large clods, hard lumps, rocks 2 inches (50 millimeters) in diameter or larger, and litter shall be raked up, removed, and disposed of by the Contractor. Refer to *Standard Specification* 8-02.3(4) for more information.

Areas to be seeded without top soils are to be prepared after final grading so that the soil surface is rough and loose, with ridges and furrows (narrow depressions) perpendicular to the slope or to the natural flow of water. This will slow the water velocity, increase water detention and infiltration, decrease runoff, and promote grass growth. This can be done through the use of a cleated roller, crawler tractor, or similar equipment. Refer to *Standard Specification* 8-01.3(2)A for more information.

Seed and fertilizer are to be uniformly applied on the slopes at the rate and mixture specified in the contract. Application shall be by an approved hydro-seeder, blowing equipment, properly equipped helicopters, or power drawn drills or seeders. Where areas are inaccessible for this equipment, or when specified, approved hand seeding will be permitted.

In order for the Contractor to order the proper amount of materials for the project and to provide the Inspector a method of checking the rate of application of the seed and fertilizer, the Project Engineer should measure the areas to be seeded and fertilized as soon as they can be determined and inform the Contractor of the anticipated acreage. If, in the opinion of the Engineer, the seeding and fertilizing areas can be accurately determined using digital terrain modeling or other design data, the Engineer has the option of using this data in lieu of field measuring. During the seeding and fertilizing operation, the Inspector shall see that the material is placed at a uniform rate and compare the amount of seed and fertilizer applied, by counting the number of bags of material, with the area covered to verify that the proper rate of application is being placed.

The seed and fertilizer may be applied in one application provided the seed and fertilizer are not mixed more than 1 hour prior to application. Mixing more than 1 hour prior to application will damage the seed. Otherwise, the seed shall be applied in a separate application prior to fertilizing and mulching. Lime should be applied separately from the seed and mulch.

Wood Cellulose fiber may be applied with seed and fertilizer West of the summit of the Cascade Mountain Range and only upon written request by the Contractor and approval of the Engineer East of the summit of the Cascade Mountain Range. Consult with the Regional Landscape Architect, the State Regional Liaison Landscape Architect, or the State Horticulturist.

Mulch must be uniformly applied to the seeded areas within 48 hours after seeding. Straw mulch is to be applied with a forced air spreader. Straw mulch may not be practical in windy areas. Wood cellulose fiber is normally applied with hydraulic equipment. Checks are also necessary to determine that the mulch is applied uniformly and at the required rate. In areas, which cannot be reached by a mulch spreader, hand methods resulting in uniform application may be used.

In some areas, it may be desirable to anchor the mulch with an application of tackifier. The *Standard Specifications* are quite complete in the method of applying tackifiers see Section 9-14.4(7). The rate of application is varied from area to area to obtain the best results. Check with the Regional Landscape Architect, the State Regional Liaison Landscape Architect, or the State Horticulturist for advice on the proper application rate.

In order to control the possible erosion resulting from fast runoff on steep slopes, Erosion Control Blanket or matting is often used (see Chapter 6 of the *Highway Runoff Manual* M31-16). It also has its use on flatter slopes where erodible soils are encountered. The purpose for using Erosion Control Blanket is to provide a quick temporary protection until the grass has grown enough to be permanent protection for the soil, but the Erosion Control Blanket cannot be expected to cope with water other than rainfall that falls on the exposed slope. Ditching or drains should control drainage from above or beyond the raw slope. The Inspector is charged with being alert to this potential problem and making every effort to ensure that this kind of runoff is diverted away from the slope.

8-1.6 Measurement and Payment

Measurement and payment instructions for Temporary Erosion and Sediment Control work are covered in Section 8-01.4 and 8-01.5 of the *Standard Specifications*. In some cases, a separate bid item will be established for extra fertilizing to permit additional applications on a seeded area during the life of the contract. In these cases, payment for the acreage fertilized will be made for each application.

8-2 Roadside Planting

8-2.1 General

Inspection of all roadside plantings should be performed by trained and experienced personnel. Recognizing that this is not always possible, this section is written to serve as a guide for project personnel. It is not intended as a substitute for professional assistance. Project personnel will find the *Roadside Manual*, M 25-30, and in particular Sections 700, 710, 720, 800, and 820 useful. When questions of adequacy of planting stock and procedures are encountered, or when differences of opinion concerning the acceptance or rejection of plants occur and the answers are not readily found in this section, the Inspector should request the assistance of the Regional Landscape Architect, the State Regional Liaison Landscape Architect, or the State Horticulturist. In cases where insect damage and diseases are suspected, the services of an entomologist or plant pathologist may be required.

Construction activities, especially clearing, grubbing and excavation, may damage existing trees and shrubs that are scheduled to remain. If this happens, or if pruning of live vegetation is required, the Inspector may contact the State Liaison Landscape Architect or the State Horticulturist for assistance. Early identification and remediation of the damage will minimize shock to the vegetation.

The highway right of way is largely a construction disturbed environment, lacking in natural soil profiles and subject to unusual runoff, abnormal air turbulence, pollutants, temperature variations, and other extremes. In this environment, the designer is faced with providing appropriate highway vegetation.

Plants are living things in contrast to concrete, steel, and stone, which are inanimate materials. Plants change in shape, size, color, and texture from season to season and from year to year, while inanimate materials remain constant except for slight changes in color and texture due to weathering or wear.

Functional plantings serve to improve traffic guidance, reduce headlight glare, provide safety features, reduce pollution, prevent erosion, provide screening, minimize impacts to streams, and contribute to improved aesthetics. Plantings can also be used to create a smooth transition from rigid geometric cross-section and structural forms to nearby natural vegetation and land forms. They also provide gateways to communities.

Plants are also used in soil bioengineering. This practice is being used more frequently in WSDOT projects. Soil bioengineering is used to stabilize and revegetate slopes and stream banks and is often used in conjunction with traditional "hard" geotechnical fixes. For more information on the uses of soil bioengineering, see Chapter 940 of the *Design Manual* and Chapter 740 of the *Roadside Manual*.

The survival of plantings under the conditions imposed by the construction process and the environmental conditions of the site should always be a concern of the Project Office. The best conceived and designed planting may not produce the desired results if the quality of plants and the planting procedures fail to meet the requirements of the contract specifications.

Before commencing any work on the project, there should be a meeting with the Project Engineer, the inspectors, and the Landscape Architect. The agenda for the meeting scheduled by the Project Engineer should include but not be limited to the following:

- The basic concept of what is to be achieved with each individual area and the project as a whole. (Revegetation, open forest, screening, soil bioengineering, focal attention, and all other aspects to be discussed must be understood if the ultimate concept of design is to be accomplished.)
- Discuss construction issues such as mixing of soil amendments into the soil and compaction requirements. Compaction efforts for roadside plantings are different than the compaction effort required for road and bridge foundations. The ideal soil for plant grow is a loose soil with the right balance of organic matter, microorganisms, and minerals. In contrast, roadway construction requires highly compacted soils with low organic matter content for stability. These differences result in different compaction requirements. For example, soils for road foundations are compacted to 95 percent density, where as soils for plant establishment typically require a density less than 80 percent.
- The growing characteristics, weaknesses, and strong points of each plant should be discussed especially as they relate to the environment over which the Inspector has some control (drainage, exposure, etc.). Modifications of the plans should be discussed with the Regional Landscape Architect or the State Regional Liaison Landscape Architect. The list of plants should be reviewed to ensure that only plant varieties that will grow in the area have been listed. Typically, only native plant varieties should be used.
- Discuss possible maintenance problems with the maintenance personnel. Conditions that were unexpected during the design stage may lead to modifications in the plans. At the initial layout stage, the maintenance personnel may be better qualified to discuss the project. Any modifications to the plans should be coordinated with the Landscape Architect to ensure the functions are maintained.
- Discuss ongoing coordination between Project Engineer, Inspectors, and Landscape Architects to assist in the successful completion of the Project.

8-2.2 Landscape Terminology

Acid Soil/Alkaline Soil

The pH is a measure of hydrogen ions in the soil. Various plants respond differently to pH variations. Generally, the soil west of the Cascades is acidic, while east of the Cascades is more basic. The pH scale ranges from 0 to 14. A pH of measurement of 7 indicates a neutral soil. A pH measurement below 7 indicates an acidic soil. A pH measurement above 7 indicates an alkaline soil or basic soil. Generally, plants are selected for a particular area without a need to change the pH of the soil. When a pH change is desired, a soil test is taken, analyzed, and the pH is changed appropriately upon recommendations from Regional Landscape Architect or the State Horticulturist.

Balled and Burlapped (B&B)

Plants are prepared for transplanting by digging them so that the soil immediately around the roots remains undisturbed. The ball of earth and root is then bound in burlap or similar mesh fabrics. An acceptable B&B root ball should contain 90 percent (visual estimate of volume) of the earth material held together with root system when removed from the burlap.

Bare Root (BR)

Most deciduous plants are dug when dormant. The roots are cleaned, pruned, and usually stored in moist material. Roots must remain moist and not allowed to dry out.

Botanical Name

The botanical name is the plant name, written in Latin, that is used universally. The common name is the name used in a local area, and is not necessarily the same name used in other areas. The correct botanical name is usually found in "Standardized Plant Names", available from the Landscape Architect. The botanical name usually consists of two names, Genus and Species, but may include additional names.

Genus: 1st word
Species: 2nd word
Variety: 3rd word (if appropriate)
Example: Sambucus racemosa melanocarpa
Genus: Sambucus
Species: racemosa
Variety: melanocarpa

Branch

An offshoot from a trunk or main stem. It could be also called a bough or a portion of a main stem.

Bud

A small protuberance on a stem, branch or cutting containing an undeveloped shoot, leaves or flowers.

Caliper

The diameter of the trunk of a deciduous tree is measured 6 inches (150 millimeters) above ground level, up to 4-inch (100-millimeter) caliper size. If greater caliper than 4 inches (100 millimeters), it is measured at 12 inches (300 millimeters) above ground level.

Cane

A primary stem which starts from the ground of a shrub or at a point not higher than ¼ the height of the plant. A cane generally only refers to growth on particular plant material, such as roses, etc.

Clumps

Plants with at least double the number of canes required for standard material; trees with three or more main stems starting from the ground. Vine maples are sometimes sold by the clump.

Collected Material

Trees, shrubs, or other plant material collected from native stands, including Christmas tree stock and plants from native stands or forest plantings. After one growing season at the nursery, they are no longer considered collected material.

Compost

Stable, mature, decomposed organic solid waste that is the result of the accelerated aerobic biodegradation and stabilization under controlled conditions. The result has a uniform, dark, soil like appearance.

Container Grown

Plants grown and delivered to the job site in cans or other containers. Container grown plant material can be planted any time of the year and should not be allowed to dry out while in the container. Usually, plants grown in containers are in a very free draining soil mixture made up of nutrient free components. Container grown plants have a tendency to dry out and decline in vigor when not under the care of the nursery. Container grown material should have a firm root ball which will hold 90 percent (visual estimate of volume) of the ball material when removed from the container. Good container grown materials will hold virtually all of the soil in the root zone when a good growing medium is used. Some root growth should be visible in the outer edges of the ball. Excessive roots at the bottom of the ball indicate lack of proper root pruning. Excessive roots at the side or bottom of the container could indicate a root bound condition.

Cuttings

Cuttings are detached leaf buds or portions of branches which under favorable circumstances are capable of producing roots when placed in a growing medium. Common species used as cuttings are willow, cottonwood, and red osier dogwood.

Fertilizer

Any natural or artificial material added to the soil or directly to the leaves to supply one or more of the plant nutrients. Generally, a complete fertilizer refers to a fertilizer that contains nitrogen, phosphorous, and potassium (NPK). Indications on a container are usually numerical 10-8-6 or 20-10-5, etc. These numbers indicate the percentage of actual nutrient element available, i.e., 10 percent nitrogen, 8 percent phosphorous, and 6 percent potassium (10-8-6). Other minor nutrients are sometimes added to NPK such as magnesium, manganese, boron, iron, zinc, calcium, sulfur, etc.

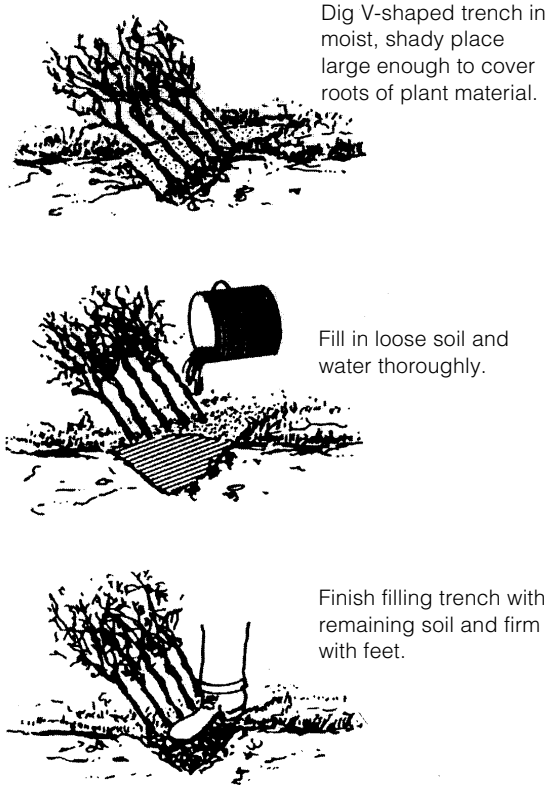
The nitrogen in a fertilizer can be readily available or slow release (controlled availability) depending upon how water soluble it is. The slow release nitrogen (high percentage of water insoluble nitrogen) will allow the nitrogen to be available to plants over a long period of time. The readily available 100 percent water soluble fertilizer can leach away with heavy rains or damage the plant by the high concentrations of nutrient. Additional nitrogen and other elements are often necessary for plant growth when mulches are used. The decaying activity of the mulch ties up the plant nutrients and is thus unavailable for plant growth.

Applying the wrong type of fertilizer can harm or kill plants. Consult with Regional Landscape Architect, State Regional Liaison Landscape Architect, State Roadside and Site Development Manager (Design Office), or State Horticulturist before applying fertilizers not specified in contract. In addition, approval by the State Construction Office may be required and approval by the Project Engineer and Regional Construction/Operations Engineer's Office is required (see the Change Order Check list).

Heeling In

A method of temporary storage by covering plant roots with moist sawdust, mulch, or a mixture of other materials capable of good moisture retention, to keep the roots from drying out.

Method for Heeling in Plants



Herbicide

A herbicide is a pesticide chemically formulated to control or destroy weeds. Herbicides are broken down into main groups: Postemergence Herbicide and Preemergence Herbicide. Postemergence herbicide is a plant killing material that acts on the active growing surface of a plant after the plant has emerged from the soil. It is usually most effective during the rapid growth of the plant. Preemergence herbicide is a plant killing herbicide which acts to prevent the seeds, bulbs, tubers, stolens, etc., from sprouting (before-emergence).

Inoculated Seed

Seeds of the legume family (i.e., clover) that have been treated with nitrogen-fixing bacteria to enable them to make use of nitrogen from the soil atmosphere.

Mulch

Mulch is any loose material placed over soil, usually to retain moisture, reduce or prevent weed growth, insulate soil, or improve the general appearance of the plant bed. Additional fertilizer is sometimes necessary in order to offset the loss of plant nutrients used by the microorganisms that break down the mulch, especially when using non-native stock.

Mycorrhiza

A beneficial group of fibrous fungi that engulf soil particles and pore spaces to absorb water and nutrients in solution and transfer this solution to the roots of plants. In effect, they multiply the plants' root systems many times.

Node

A small protuberance on a stem, branch or cutting containing an undeveloped shoot, leaves or flowers.

Pesticide

A pesticide is any substance or mixture of substances intended to control insects, rodents, fungi, weeds, or other forms of plants or animal life that are considered to be pests.

Puddling

Puddling is a process used to settle the soil with water by eliminating air pockets during the planting process.

Root Ball

Ball of earth encompassing the roots of a plant. Generally, the root ball will have a good portion made up of root networks. A "manufactured-root ball" is one where the root system is not adequate to hold the soil in place. Manufactured root balls should not be accepted, since the root system is not developed sufficiently.

Rootbound (Pot Bound)

The condition of a potted or container plant whose roots have become densely matted and most often encircle the outer edges of the container. Generally, this condition is a result of holding the plant in the container for too long a period. Root bound plants should be rejected. See Section 9-14.6(2) of the *Standard Specifications*.

Root Collar (Plant Crown)

Root Collar is the line of junction between the root of the plant and its stem, also known as the plant crown.

Runner

A long, slender, trailing stem that puts out roots along the ground. Where the nodes make contact with the ground, a new plant is produced. (For example: Kinnikinnick or wild strawberry.)

Soil Bioengineering

Soil bioengineering combines the use of live plants or cuttings, dead plant material, and inert structural members to produce living, functioning land stabilization systems.

Soil Mixture

A mixture of growing medium such as sand, sawdust, perlite, vermiculite, peat and bark dust which is used to grow plant materials. The soil mixture usually contains two or more items and may be combined with the native top soil.

WSNLA

Washington State Nursery and Landscape Association.

8-2.3 Reference Reading

It is recommended that each office administering roadside planting, view point development, and rest area contracts, obtain and maintain a library of books and reference materials listed under Additional Sources of Information in Section 800 of the *Roadside Manual*, M 25-30, before the Contractor commences work. Most of what follows is taken from *Inspection Guide for Landscape Planting* published by AASHTO.

8-2.4 Inspection of Planting Stock

A. Inspection at the Nursery

Whenever possible, an inspection of planting stock should be made at the nursery or other approved source to ensure that quality planting stock will be provided. The Regional Landscape Architect, or the State Regional Liaison Landscape Architect, and/or the State Horticulturist should be requested to attend or participate.

The size and quality of planting stock cannot be rigidly standardized because of varying growing conditions. Judgment should be exercised and allowances made for reasonable variation in growth and appearance.

All planting stock should be of the genus, species, variety, and sizes specified and shall conform to the contract specifications for the particular species, or variety, regarding straightness of trunk, branching structure, proportion, and size of material.

Individual plants should be measured to determine conformance with contract specifications. If a particular detail of measurement has not been specified, the current edition of "American Standard for Nursery Stock, Z60.1" should be used.

Inspection at the nursery or other source of supply should include the following checks:

1. Check the general condition of the plant in the block from which the stock is to be taken for:

    a. Uniformity of Leaf Coloration: Plants which exhibit yellowing or other discoloration could indicate poor drainage, fertilizer deficiency, herbicide damage, insect damage, or disease, and may not meet specifications.

    b. Bud Development: During dormant periods of the growth cycle, plants should have buds that are firm, moist, and uniformly spaced. A slight cut into the bark may be made to determine that the cambium or growing layer just beneath the bark is moist and green.

    c. Uniformity of Growth: The plants in any given block should exhibit uniform vigor and health. Plants with less growth and which are less vigorous than the majority of the plants in the block may not be acceptable.

    d. Spacing of Plants in the Row: Vigorously growing, well-rounded, fully developed plants will transplant well. Quality nursery stock should be grown with sufficient spacing to permit good development of the individual plant. Plants spaced too closely may be extremely high headed.

    e. Soil: Plants to be balled must be grown from soil which will hold a firm ball. Broken or loose balls are a cause for rejection because of possible damage to the hair roots, a very important part of the plant's feeding system.

    f. Presence of Weeds: An overgrown, weed-infested nursery block indicates lack of care and the plants growing in it may be in a poor state of vigor because of the weed competition. Weeds should not be growing in containers.

2. Check individual plants for freedom of defects such as:

    a. Decay: On trees, look for spots of decayed tissue on the trunk and branches.

    b. Sunscald or Sunburn: The destruction of tissue caused by the sun rays striking a plant on the south or southwest side. This may result in the death of cambium tissue and bark, exposing the plant to secondary insect and/or disease infestation.

    c. Abrasions of the Bark: Abrasions severe enough to damage the cambium tissue may be sufficient for rejection.

    d. Girdling Roots: Roots that grow around another root or a stem, thus tending to strangle the plant.

    e. Improper Pruning: Stubs resulting from improper pruning, which have died back, are an excellent point of entry for disease organisms. All cuts should be flush with the trunk or supporting branch. When a cut is made to encourage branching, it should be made back to a bud.

    f. Frost Cracks: Long vertical splits in the bark and/or wood may occur on the south and southwest sides of young and thin-barked trees. Such cracks may become invaded by canker or decay-producing fungi and bacteria.

    g. Signs of Injury: Dead leaves, dry buds; dieback of twigs and branches; blackened sapwood and sunden, discolored patches of bark (sunscald) on the trunk or limbs.

3. Check individual plants for freedom from plant problems such as:

    a. Diseases: These will appear in a variety of forms such as abnormal growth of leaves, twigs, fruits, discoloration of leaves and bark, unusual discharges of sap through the bark, etc. Any plant showing evidence of disease should be rejected.

    b. Insects: Look for insect eggs, spider webs, or evidence of damage from insect feeding on leaves, twigs, buds, or other plant parts. Examine the trunks of trees for borer holes which appear as tunnels drilled into the bark and inward into the wood of the trunk. Trees with evidence of borers or other insect damage should be rejected.

4. Check individual plants for proper habit of growth as follows:

    a. If a particular habit, i.e., single stem, multiple stem, etc., has been specified, be sure to obtain plants that conform to this requirement.

b. If no particular growth habit has been specified, then the current "American Standard for Nursery Stock, Z60.1" as published by the American Association of Nurserymen should be used as a guide.

c. Shade and flowering trees should have top growth symmetrically balanced. Shade trees should have a single leader. The branching should be well developed and characteristic of the species.

d. Evergreen trees should be full foliaged plants with uniform density. Sheared plants, such as Douglas Fir sheared for Christmas trees, should be avoided unless specified.

e. Shrubs should be well branched in a manner characteristic of the species. The current "American Standard for Nursery Stock, Z60.1", is an excellent guide for determining the proper number of branches for certain size shrubs.

5. Check all container grown plants to determine that they meet the requirements outlined in 1 through 4, above. In addition, a random sampling of plants should be removed from their containers to determine that the root system is healthy. Plants which are found to be pot bound and plants which have insufficiently developed root systems to hold the soil together when removed from the container should be rejected. Healthy roots should be able to hold the soil mass together yet not be crowded around the outside perimeter of the container.

6. Planting stock which is based on the above criteria may be tagged with seals placed on all plants or representative samples at the nursery. This will assist in future inspection of these plants when delivered on the job site. Seals placed on planting stock for later identification do not imply acceptance on the construction site.

B. Inspection at the Construction Site

Inspection of stock at the construction site is to ensure that the plants are from an approved source, are in a healthy and undamaged condition, and conform to sizes, quantities, and standards called for in the specifications. Plant samples lots should be established and a representative number of plants should be inspected per Section 9-4.44 of this manual.

This inspection should consider the condition of the plant and the use of proper handling procedures from the time of digging to delivery at the construction site. If there are questions about the following check list, consult with the State Horticulturist for clarification.

Inspection at the construction site should include the following checks:

- Each shipment of plants should be free of disease and insect pests, and meet all applicable State and Federal certification requirements. All necessary quarantine or State nursery inspection certificates should accompany each shipment.
- All trees and a representative sample of shrubs should be legibly tagged with the correct botanical name, common name, and size to agree with the specifications and plant list. Bare-root plants should be shipped in bundles with each bundle properly tagged.
- Planting stock which has not been inspected at the source should be inspected as appropriate, in accordance with items 1 through 6, "Inspection at the Nursery". This should be done as the material is being unloaded, or immediately thereafter, so that plants which are unacceptable can be set aside for removal from the project site.
- Where root formation is irregular, measurement of the spread of bare-root plants should be the average, considering all sides of the plant, rather than the maximum root spread. The Inspector may allow moderate deviations (± 10 percent) from exact measurements in the case of plants which normally have irregular root systems. Example: Vine Maple.
- Large root stubs on nursery grown balled or bare-root stock should be considered evidence of lack of proper care and root pruning, and sufficient grounds for rejection of such plants. Root stubs frequently characterize "collected" stock and precautions should be taken to ensure that root systems are adequate.
- Damage to plant material caused by improper operation of mechanical diggers may be sufficient cause for rejection at the construction site. Plants dug with equipment leaving a cone-shaped ball should be carefully checked to make sure that an excessive portion of the root system has not been cut away. Feeder roots are the newly formed roots, usually white in color.
- Bare-rooted plants should have adequate live, damp, fibrous roots, free of rot and mold. Earth balls should be unbroken and of specified size.
- Precautions should be taken to prevent the drying of root systems in all shipments of plants to ensure arrival in good condition. During transport, plants must have been protected by a covering such as canvas or plastic sheeting. Bare-root plants should have been protected by moist burlap, sawdust, plastic, etc. Under no conditions should the roots system have been allowed to dry out. All plants must exhibit normal health and vigor.

Following completion of inspection, all plants accepted should be carefully stored as required until planted.

C. Storage of Plants

Plants not planted on the day of arrival at the site should be placed "in storage" and handled as follows:

- Outside storage should be shaded and protected from the wind.

- Plants stored on the project should be heeled-in to protect them from drying out at all times by covering the bare root or balls with moist sawdust, wood chips, shredded bark, peat moss, or other approved mulching material. Plants, including those in containers, should be kept in a moist condition until planted by using a fine mist spray or soaker hose, instead of a heavy stream which may cause damage.

8-2.5 Layout

The layout of landscape features should clearly show where exact dimensions are required and where some variances will be permitted. Accurate location of all buildings, roads, walks, paved areas, and features such as sculptures, walls, pools, etc., must be accomplished. Landscape beds, trees, and indigenous features must be laid out to mold the Landscape Architect's patterns to the existing topography and available area. Some variances are generally allowed in the bed areas and tree locations of the proposed plan to fit the particular situation, however, coordination with the various other plans and with the Landscape Architect is advised.

The layout of planting areas in wetlands is critically important to its success. Many plants have exact water requirements and will not thrive or even survive if planted in water too deep or too shallow. Changed conditions happen frequently during the grading phase. Every effort should be made to assure the hydrology of the wetland is as the designer intended before planting. Close coordination with the designer during the grading and plant layout phases can identify potential problems and fix them before they become costly mistakes.

Trees must be adjusted for minimum clearance to roadways and allowances must be made for mowing (especially when the tree is fully grown). One must ensure that placement of trees is not over existing utilities or drains or that tall growing trees are not placed under overhead utility lines. Shrubs and ground cover beds are often intended for unmowable areas. The outline must be adjusted to fulfill the intent and the edge should create a "flowing" outline that is aesthetically pleasing and mowable. It is important that sufficient stakes are used to clearly outline the planting areas.

Inspection During Planting

The Inspector should determine that planting operations at the construction site are properly completed in conformance with contract plans and specifications and good horticultural practices.

Planting stock on hand and ready for planting at the construction site should have been inspected upon delivery, in accordance with the checklist under "Inspection at the Construction Site".

A. Preliminary Preparation

- The Inspector and Contractor should jointly review and become familiar with all plan sheets, quantities, details, specifications, and other provisions of the contract. At this time, questions or interpretations can be answered or problems resolved through discussion with the Landscape Architect, the State Horticulturist, or other authorized persons.
- All materials that have specification requirements shall have an approval of source prior to incorporation or use on the project. Additionally, samples of these materials will be required to verify that the specifications are being adhered to. See Chapter 9 for further instructions and Chapter 8-2.6 for examples.
- The Inspector should check and approve the stakeout of all planting areas and planting hole locations prior to excavation. Minor relocation of planting areas and holes can be done at this time to avoid utility lines, rock outcrops, drainage ditches, or impervious or wet soil conditions. If minor relocation of plantings are not possible, the Inspector should contact the Landscape Architect to adjust the design requirements.

B. Site Preparation

Prior to installation of plant materials at the construction site, the following preparation should be completed according to the requirements of the contract plans and specifications.

- Control weeds around planting holes or entire bed areas as called for by the contract specifications. The Inspector should check to be sure that weed root systems have been killed. The interior color of dead or dying roots is usually tan or brown, whereas healthy roots are usually white. If the weed's root systems are alive, planting should be delayed until they can be killed. Perennial weeds with extensive root systems such as Canada thistle, Horsetail, Wild pea, Field bindweed, and Quack grass (see Common Weeds of the United States - United States Department of Agriculture) should not be controlled by hand weeding; they should be controlled with herbicides by a licensed applicator.
- Excavation of planting holes, pockets, or beds to the required size and depth and spaced as shown on plans.
- Preparation and stockpiling of backfill mixture as called for by contract specifications.
- The planting holes are to be excavated minimally to the sizes indicated on the contract plans. In mixed planting areas, usually trees are planted first followed by the larger shrubs, low shrubs and finally planted with ground cover plants. The holes for trees and large shrubs may be dug well ahead of time, provided that

the holes are backfilled with an approved soil or soil mix within a day or two after digging. Where drains are needed, they are not to be dug or backfilled until planting time. This provides good inspection to aid in determining if a drain is actually warranted. Before backfilling, especially in drilled holes, the sides and bottoms must be scratched and loosened to break all "glazing". This promotes moisture transfer between different soils (existing and backfill).

C. Interim Care of Planting Stock

Care must be taken to avoid damaging plants being moved from the storage area to the planting site. Balled and Burlapped (B&B) plants should be protected against drying and handled carefully to avoid cracking or breaking the earth ball. Plants should not be handled by the trunk or stems. Bare-root plants should be "puddled" when removed from the heeling-in bed to protect the roots from drying. Plants should be protected against freezing or drying by a covering of burlap, tarpaulin, or mulching material during transportation from the heeling-in bed to the planting site. Should damage occur, or be found at this time, the plants should be rejected and removed from the site.

At the time of planting, the Inspector should be alert for any damaged balls, leaders, major branches, or roots. Pruning should be permitted to remove minor damaged branches which will not affect the characteristic shape of the plant (see *Western Garden Book* - Pruning Techniques). All rejected plants should be replaced during the current planting season.

In order to ensure against reuse of discarded plants, seals should be removed and the trunk or stems above the root crowns should be marked with a small spot of paint or dye. Since discarded plants are the property of the Contractor, they should not be marked or mistreated in such a way as to make them unfit for other uses.

D. Planting Operation

Unless in conflict with the contract specifications, the following check list of horticultural practices may be used by the Inspector.

- Plantings should be performed only during the specified planting season.
- The Inspector should check for proper positioning of the plants and the spread of the bare root system in the planting hole. When laying out shrub and ground cover beds, it is essential that the perimeter be defined by placing plants in a flowing line that clearly outlines the bed border. The interior should then be staked in accordance with the plant pattern and spacing. Before B&B plants are set, burlap and any twine should be completely removed. If the burlap is allowed to remain above the ground, it will generally act as a wick and thus the plant will be surrounded by a dry barrier which the roots cannot penetrate. The twine should be cut and, if degradable, must be buried or it will girdle the plant and the death of the plant will result. If non-biodegradable materials have been used, they should be removed entirely.
- When planting Bare Root or Potted Ground Covers: If the soil is dry, irrigate the planting bed the day before planting. If irrigation is not available, delay the planting until the soil is moist. The flats may be tilted up and the ends jarred against the ground to shift the soil and plants toward the lower end. Flats must be watered the day before planting. Block or cut out the plants and remove from the flat, retaining as much soil as possible. The hole must be large enough to take the root system without forcing or distorting.
- Check for correct depth of the root collar. Tree root collars should be above ground. All plants should not be planted deeper than they were growing in the nursery.
- Place approved backfill material around plant roots or plant balls, being careful not to damage the ball or the fine root system of bare-rooted plants. Backfill which is frozen or saturated should not be used.
- Eliminate air pockets in the backfill by filling, tamping, and watering as required by the specifications. It is generally advisable to water the plants thoroughly before the backfilling of the pit is completed. Container plants should be moist at the time of planting.
- When the above operations have been completed, unless otherwise specified, a berm of soil should be placed around the perimeter of the pit to form a basin or saucer to facilitate watering and retention of rain or irrigation water. When planting on slopes, the berm should be on the downhill side only. This allows the plant to catch runoff from up slope.
- Plants should be mulched to the specified depth with approved mulch material. Tree root collars should be above the mulch. The use of mulches around plants prevents rapid temperature fluctuation, reduces moisture loss, and aids in weed control. Care should be given to the mulching of ground covers, so as not to bury these plants with mulch.
- Sometimes it is found that excessive moisture will necessitate drastic curtailment or elimination of planting in an area, or a different plant may be required. Consult with the Landscape Architect or the State Horticulturist when excessive moisture is encountered. Mounding may be considered when it

is necessary to raise the bed above the water table. It is lack of oxygen around the roots of plants that usually kills the plant

E. Wrapping, Staking, and Pruning

All plants should be wrapped, and staked if specified.

- Stakes should be driven solidly into the ground and guying installed to prevent excessive movement of the plant until the root system is firmly established in the new planting location. Guys shall be loose enough to allow approximately 6 inches (150 mm) of movement. This movement stimulates the roots and trunk to grow and increases stability.
- Trunks or stems of plants should be wrapped from the root collar or plant crown to the lower limbs with approved material to protect against drying or other physical damage.
- All broken, torn, or damaged roots should be pruned, leaving a clean cut surface to help prevent rot and disease.
- Trees normally should not be pruned except for broken branches, unless otherwise specified or directed.
- All guying shall be removed at the end of the first year of plant establishment.

Watering

The planting operation is completed by watering all plants as specified. Weather and soil conditions dictate the need for watering. Over-watering is as harmful as under-watering.

8-2.6 Materials

Materials on landscaping projects include many items besides plant material, such as planting media, pesticides, fertilizer, mulch, staking and guying material, irrigation/ electrical material (pipe, pumps, sprinklers, backflow control devices, valves, etc.) drainage, surfacing, and more. Chapter 9 of this manual, covers the inspection and testing of the more common highway construction materials encountered.

Plant Material

Sampling of plant materials must be done with judgment and selectivity. Look the entire lot over, carefully, noting the general size differential, and coloring, the sturdiness, the shapes, needle dropping on evergreens, condition of bare root, bare root drying, density of bare root hair and fibrous root system, firmness of the ball for B&B, general size of balls, wrapping method, evidence of handling methods, and all items of emphasis pointed out in the plans and specifications.

Bare root plants must be dormant when gathered and prepared for shipping. This can normally be ascertained in distant areas by calling on the services of the agricultural extension agent in the vicinity of the nursery. If trees are not generally dormant, an on site inspection must be made as nurseries may be able to satisfactorily induce dormancy by cold spraying or other means. The normal test for dormancy is observation; if the plant has been subjected to cooling environment and the majority of the leaves have fallen naturally it is a good indication of dormancy. Expert advice from the State Horticulturist should be obtained in all other cases.

The *Construction Manual*, Section 9-4.44, requires the Contractor to submit a sample of each plant specified, except trees. Photographs shall be submitted for trees. These photographs are to clearly show enough detail for positive identification of the variety and form of the plant materials. The purpose for these samples is to identify all of the plants to verify that they are the plants intended by the Landscape Architect. These samples should be properly cared for at the field office so the project staff may study and learn to recognize them through association.

Planting Media

Various additives are used to improve the root growing environment of the soil that exists on the site (such items as perlite, biosolids, sand, gravel, compost, sawdust, peat, etc.). The additives may be either used singularly or incorporated into the existing soil. The planting (growing) media material should be checked against the specification.

Pesticides

Pesticides should be applied, by a licensed applicator. The label should be checked for the proper material and timing of application. The pesticide label will give instructions such as intended use of the product, directions for use, and warnings. The label also indicates if the material is registered for use on a particular type of plant material. The Pesticide Application Record (WSDOT Form 540-509) shall be completed daily by the Licensed Applicator with a copy to the Project Engineer daily. The Project Engineer shall distribute a copy of this record daily to the Regional Operations or Maintenance Engineer and to the Roadside Maintenance Section at the State Maintenance and Operations Office in Olympia.

Fertilizers

Fertilizers should be applied in accordance with the specifications. The formula should be cross checked with the specifications and the label on the bag or container. When water soluble nitrogen fertilizers are used, particularly in lawn areas, adequate moisture is needed to prevent fertilizer burning.

Irrigation Materials

Irrigation materials include such items as piping, backflow control devices, valves, backfill material, electrical, sprinkler heads, etc. They are normally approved by the State Materials Laboratory. These items should be cross-checked with the specifications and/or the Landscape Architect to ensure products are satisfactory and are being installed correctly.

Drainage

Drainage materials include gravel backfill, culvert piping, French drains, etc. These drainage items should all be checked as to functionality and compliance with the *Standard Specifications*.

Surfacing

Surfacing may take the form of gravel, asphalt, cobblestones, concrete, brick, wood, combinations of different materials, etc. The use expected, effect desired, and budget allowed determines the material selected. The surfacing materials should be checked in accordance with the specifications.

8-2.7 Progress Schedule

The Contractor's progress schedule should show the order in which the Contractor proposes to perform the work within the contract time. It should show the beginning and completion times for the several prominent features of the work provided in the contract. If specified by the contract, such schedule will be in the form of bar graphs developed under the critical path method, PERT, or other methods. Upon request of the Project Engineer, the Contractor will submit supplementary progress schedules in the form required by the Project Engineer. In the case of material to be grown, it shall, in detail, specify planting and propagation times. Times in or out of greenhouses and times shown for activities related to dormant or seasonal requirements will be anticipated times to be adjusted to actual times for the year involved when they become known. The "energizing" time for electricity and water must be checked with the servicing utility for feasibility and scheduling.

The schedule must contain the weed control plan before starting work on the project, the anticipated planting per day, and areas to be worked concurrently. The underground irrigation, electrical, or other work within the planting areas must be completed and working before planting.

The correct timing for herbicides, fertilizing, mulching, pruning and all other phases must be specified in relationship of one event to another.

8-2.8 Inspection During the Plant Establishment Period

The completion of planting in any given area may proceed the start of plant establishment by considerable time. When plant establishment is started, the area should be inspected to make sure that all plants are in place and healthy. Additional inspections of the planting areas should take place on or near the first of each month during the Plant Establishment Period to spot any potential problems that the Contractor needs to attend to.

Although planting stock has been properly selected, delivered to the planting site in a vigorous, thrifty condition, and planted in accordance with good horticultural practices, survival and normal growth depend to a large degree upon appropriate care during the establishment period.

If differences of opinion concerning the need for a particular procedure occur, and the answers are not readily found in this guide, the Inspector should seek the counsel of a the State Horticulturist or landscape architect.

Ideally, the establishment period should encompass the time required by the plantings to become acclimated to the growing conditions at the planting site. The project specifications should clearly indicate the length of the establishment period, which may vary from one area of the State to another, depending on the local conditions, climate, and the type of plant materials utilized.

A well rounded program of horticultural practices used during the establishment period may include watering, fertilizing, pruning, insect, disease, and weed control, and replacement of unsatisfactory plants in accordance with the specifications.

A. Inspection Check List

The following inspection check list includes critical items which should be observed periodically during establishment.

- Plants must be kept in proper position as appropriate for the species. Plants may require repositioning as a result of settlement, wind action, vandalism, etc. Care should be exercised in straightening to minimize disturbance to the root mass and should include replacing topsoil as required.
- Stakes should be firmly imbedded, redriving may be necessary.
- Guy wires may need to be adjusted to keep the tree straight.
- Protective wrapping on trunks or stems should be secure.

- Vehicular, fire, or damage due to vandalism should be noted and corrective action taken.
- Note damage caused by animals (i.e., deer, rodents) and seek advice on control measures.
- Report infestations of insects and disease to the State Horticulturist or other appropriate professional for corrective action.
- Inspect for broken branches or sucker growth and have them removed by pruning.
- Where discoloration of foliage occurs, especially in evergreen material, advice on corrective measures should be sought.
- Dead and severely damaged plants should be removed immediately and replaced during the next appropriate planting period.
- Inspect for settlement of soil or soil mix and replace to required grade, repositioning the plant if necessary.
- Check overall depth of mulch and add or replace as required.
- Inspect berms and water basins (constructed for the purpose of retaining water) to ensure that they are functioning properly. Repair and rebuild as necessary.
- See that project areas are weeded as specified.
- If natural rainfall during the establishment period is insufficient for normal plant growth, supplemental water should be supplied. The method of application and quantity of water used should be specified.
- If planting projects require the use of fertilizers, specifications should be followed.

B. Inspection at the End of the Plant Establishment Period

The inspection should include a plans-in-hand review of each planting area or bed to determine that the arrangement, number, and species of healthy plants called for on the planting plans are present.

Since this inspection is of major importance to the ultimate success of the project, a landscape architect and the State Horticulturist, as well as the Inspector and Contractor, should be members of the inspection team.

All plants rejected during the inspection should be removed and replaced by new plants which meet all of the requirements of the contract and the *Standard Specifications*.

The final acceptance of the project shall not be completed until all plant requirements have been satisfactorily made.

8-2.9 Measurement and Payment

Measurement and payment instructions are covered in Sections 8-02.4 and 8-02.5 of the *Standard Specifications*.

Payment for trees, shrubs and ground cover plants is to be made as specified in the contract. The Project Engineer shall make an inspection of the planting areas before payment is made, to determine if the required work has been accomplished and the number of plants are in a healthy condition. No payments shall be made for plants that are not in a healthy condition, although partial payment may have been made following a previous inspection.

8-3 Irrigation System

8-3.1 General

Irrigation has been defined as the artificial watering of land (as by canals, ditches, pipes, or flooding) to supply moisture for plant growth.

Frequently, irrigation systems are designed to produce optimum soil moisture levels, thereby encouraging maximum plant growth and/or maximum crop yield. The use of irrigation in WSDOT landscaping projects differs from this, however, since our primary concern is different from that of commercial growers.

The objective of WSDOT is to help ensure plant survival by supplementing natural precipitation during dry periods. This can often be accomplished with far less water than that required to obtain maximum growth and yields. Application rates of irrigation systems are, therefore, designed from the standpoint of minimum moisture requirements of the plants.

A properly designed and installed irrigation system will distribute water uniformly over the intended planting area at a predetermined precipitation rate. Many factors influence the efficiency of a system's operation and must be taken into consideration during the design stage. In addition, care must be taken when inspecting installation of the irrigation system to ensure that the system not only follows the designer's intent, but also fully conforms to the *Standard Specifications*, project plans and provisions, and the manufacturer's requirements and recommendations.

The most efficient and economical irrigation design is only as good as its installation, and this depends upon careful and thorough inspections.

8-3.2 Layout

Turf areas and planting beds shall be laid out prior to staking the irrigation system. If adjustments to the irrigation system are required, they must produce a system which will provide a uniform sprinkling pattern without leaving dry areas.

Sprinkler heads to be located adjacent to the perimeter of planting beds should be laid out first to approximate as closely as possible the designed or approved revised configuration of the planting area. The remainder of the planting area should then be filled with the spacing between heads not to exceed that which is shown on the plans or recommended by the manufacturer.

Review all layouts and measure the distance between adjacent heads to ensure that full coverage of water will be attained. If the pattern is not uniform in coverage, or if the distance between heads exceeds that recommended by the manufacturer, the layout will need to be adjusted.

Unless otherwise specified in the project provisions, all irrigation systems shall be completed, tested, approved, and properly backfilled before landscaping can begin.

Advise the Regional Landscape Architect when the irrigation system has been staked in the field.

8-3.3 Materials

All components intended for use in an irrigation system must receive approval from the Materials Engineer prior to their incorporation into the project.

Approval of items is determined from information supplied on the Request for Approval of Material (RAM), Form 350-071, and accompanying catalog cuts. Items selected off the *Qualified Products List* are already approved for use and do not require the submittal of a RAM. All components of the irrigation system shall be listed and identified by their corresponding bid item number where applicable. Sufficient information must be included to positively identify each item listed. Each item shall be identified by size, catalog number, and the name of the manufacturer.

Four copies of catalog cuts of all items listed shall accompany the RAM. Notification of approval or rejection of either the source or the components will be forwarded by the State Materials Laboratory to the Project Engineer. The Project Engineer will inform the Contractor of the approval action.

If samples are requested for preliminary evaluation, it will be the Contractor's responsibility to obtain and submit the designated items to the State Materials Laboratory for testing. Unless destructive testing is required, all items will be returned to the Contractor upon completion of testing, at which time approved items may be incorporated into the project.

8-3.4 Inspection

An efficient irrigation system is the result of, and depends upon, proper design, installation, and maintenance.

A properly installed system is one that not only follows and fulfills the designer's intent, but which, in addition, meets the requirements of the project plans and documents and has been installed according to the manufacturer's suggestions and recommendations.

Thorough inspections, carefully conducted during construction, are of utmost importance to help ensure proper installation. To be adequately prepared for inspecting the installation of irrigation systems, it is of great benefit for the Inspector to have previous knowledge, preferably some experience, in at least one of the various aspects of irrigation design, installation, and maintenance. This not always being possible, it becomes necessary for the Inspector to first familiarize themselves with those portions of the *Standard Specifications* and contract documents that pertain to inspection and irrigation systems before attempting the necessary inspections. In addition, since irrigation inspection requires such varied and versatile knowledge and experience, it is advisable for the Inspector to obtain additional advice and/or assistance from WSDOT personnel having the expertise in these specialty areas.

An inspection shall be conducted on all irrigation system components delivered to the project site to determine acceptance or rejection. If at any time, until the system is completed and turned over to WSDOT, components are found that are either damaged, defective, or not formally approved for use on the project, they shall be rejected. Information indicating acceptance or rejection of components shall be properly documented and maintained by the Inspector at all times.

8-3.5 Installation

Once the irrigation system layout has been staked and approved by the Project Engineer, the Contractor may commence excavation.

Trench bottoms shall be relatively smooth to provide support along the entire length of pipes to be installed. In addition, and as specified in Section 8-03.3(2) of the *Standard Specifications*, trench bottoms shall be of sand or other suitable material free from rocks, stones, or any material which might damage the pipe.

All system components shall be installed in accordance with the project plans and documents, using methods or techniques recommended by the respective component manufacturers.

Solvent welding is a technique used to bond PVC pipe and fittings together. The solvent cement used in this type of installation is, as its name implies, a solvent which dissolves those portions of the pipe and fittings surfaces to which it is applied, to form a continuous bond between the mating surfaces. During the construction of PVC solvent weld joints, excess cement is forced out by the insertion of the pipe into the fitting socket. This excess cement, if not immediately removed, will dissolve the surface of the pipe

at its point of accumulation and will result in a permanently weakened spot. It is necessary, therefore, that this excess cement be wiped at the time the joint is made and that the Inspector check to ensure that it has been done.

Plastic pipe is subject to considerable expansion and contraction with temperature changes. To provide for this, pipe should be snaked from side-to-side in the trench.

Care shall be taken during the installation of the pipe to ensure that rock, dirt or other debris is not allowed to enter the open ends of the pipe.

Electrical control wire between the automatic controller and the automatic control valves, shall be bundled together at ten-foot intervals and snaked from side-to-side in the trench, either adjacent to or beneath the irrigation pipe. Snaking of the wire helps eliminate wire stressing or breakage caused by expansion or contraction of the earth due to variations in moisture content or extreme seasonal temperature fluctuations. Placement of the wires adjacent to or beneath the irrigation pipe is for protection against damage from possible future excavation.

Electrical splices shall be permitted only in valve boxes, junction boxes, pole bases, or at control equipment. No direct burial splices shall be allowed. Types of electrical splices allowed in WSDOT irrigation projects shall be only those approved for use by the State Materials Laboratory. Approved electrical splices are listed in the *Qualified Products List* or may be approved through the use of a RAM.

Freeze protection must be provided as specified in the project documents. Either a three-way valve with compressed air fitting for blowing water out of the lines, or drain valves placed at the low point of each lateral must be used. If the three-way valve and air fitting is to be used, it must comply with one of the designed installations approved for use by the Washington State Department of Health. If drain valves are used, care must be taken to ensure that the lateral lines are properly sloped to provide complete drainage.

8-3.6 Cross-connection Control, Backflow Prevention

A cross-connection is any actual or potential connection between a potable water supply and a source of contamination or pollution.

A cross-connection is not in itself dangerous. It is only when contamination passes through it and into a potable water system that a health hazard is created.

Backflow is the unwanted reverse flow of liquids in piping system and is the major means by which contamination of potable water can occur. Backflow is the result of either back pressure or back-siphonage. Backflow from back pressure can occur any time pressure produced in the non-potable piping system is greater than that existing in the potable side. Backflow from back-siphonage is the result of a negative or subatmospheric pressure within a potable water system, causing contaminants from the non-potable side to be suctioned in.

Irrigation systems supplied by domestic potable water systems are potential pollution hazards to the potable water. Such cross-connections require protection to prevent the possibility of backflow.

A backflow prevention, cross-connection control device is any device, method, or type of construction used to prevent backflow into a potable water system.

An approved backflow prevention, cross-connection control device is one that has been investigated and approved by an appropriate regulatory agency. The approving or regulatory agency for backflow prevention, cross-connection control devices for the state of Washington is the Department of Environmental Health. This agency periodically publishes a list of approved cross-connection control devices.

The local water purveyor determines the type of backflow prevention device to be used to protect domestic water supply systems under their jurisdiction. This determination is based upon the water purveyor's estimation of the probability of backflow occurring and the degree of hazard created if it should. Once the type of device to be used has been determined, the device shall be selected from the Department of Environmental Health current list of approved cross-connection control devices.

Installation of cross-connection control devices shall conform to the *Standard Specifications*, the project plans and documents, the manufacturer's recommendations, and the "Accepted Procedure and Practice in Cross-Connection Control Manual". In all cases, the backflow prevention device shall be tested by a certified inspector prior to activating the system. Additionally, Form 540-020, shall be filled out and the appropriate distribution made.

8-3.7 Serving Utility

The Project Engineer shall contact the serving utilities as soon as the Contractor's schedule is known, to arrange for the actual service connections, and to ensure that all agreements are completed and billing procedures are established.

8-3.8 As-Built Plans and System Orientation

The Project Engineer is required to submit As-Built Plans in accordance with Chapter 10-3.7 of this manual.

Accurate As-Built Plans are a valuable and necessary aid in designing and constructing future projects for the area, and for maintenance and repair of the irrigation system. Therefore, it is imperative that these As-Built Plans show the true location, size, and quantity of components installed.

Sections 1-05.3 and 8-03.3(10) of the *Standard Specifications* state that the Contractor is responsible for supplying working drawings, corrected shop drawings, schematic circuit diagrams or other drawings necessary for the Engineer to prepare corrected plans to show the work as constructed. To help ensure accuracy of this information requires that the Contractor or field representative record each change as it is completed. In addition, the Inspector shall inspect and verify this information prior to the commencement of backfilling. Upon completion of this, all working drawings and pertinent information shall be submitted for the Project Engineer's approval and use in preparing the As-Built Plans.

The Contractor is also required to conduct a training and orientation session for WSDOT personnel covering the operation, adjustment, and maintenance of the irrigation system. The Project Engineer shall arrange to have the maintenance personnel who will be involved with the irrigation system attend this orientation session. The As-Built Plans shall be available so they can be reviewed and all features explained. One copy of the As-Built Plans shall be presented to the maintenance personnel at that time, along with parts lists and service manuals for all equipment.

8-3.9 Measurement and Payment

Measurement and payment instructions are covered in Sections 8-03.4 and 8-03.5 of the *Standard Specifications*.

8-4 Curbs, Gutters, Spillways, and Inlets

8-4.1 General

The *Standard Specifications* specify the class of concrete to use when constructing the various items. Quite often the Contractor places the concrete for these miscellaneous items at the same time of placing concrete for other work. When this is the case, it is usually more convenient for the Contractor to use the same class of concrete for all the work during the day. At the Contractor's request, the Project Engineer may accept a higher class of concrete in lieu of the class specified at no increased cost to WSDOT. This substitution should be documented in the diary, Inspector's daily report, or other records.

8-11 Guardrail

8-11.1 General Instructions

Since guardrail is expensive to construct and requires continual maintenance, it should be constructed only where hazardous conditions justify its use. During construction, the Project Engineer should investigate eliminating the need for guardrail by flattening the slopes, or otherwise removing, relocating, or modifying the hazard whenever possible. The final evaluation of the need for guardrail should be made in the field after the embankment has been constructed. Even though the fill has been widened for guardrail, it should not be constructed if it is determined at this time that guardrail is not needed.

See Chapter 1610 of the *Design Manual* and other pertinent instructions for design criteria for guardrail.

For safety reasons, the guardrail shall have the ends flared away from the roadway and anchored in accordance with the appropriate *Standard Plans*. The construction inspector should pay particular attention to make sure that the rail washers are consistent with the current *Standard Plans*.

8-11.2 Erection of Posts

The posts shall be set to the true line and grade of the highway and spaced as shown on the *Standard Plans*. Post may be placed in dug or drilled holes. Ramming or driving will be permitted only if approved by the Engineer and if no damage to the pavement, shoulders and adjacent slopes results therefrom. The post holes shall be of sufficient dimensions to allow placement and thorough compaction of selected backfill material completely around the post.

8-11.3 Terminals

Installation of guardrail terminals listed in the *Qualified Products List* shall be by an installer, that has been trained and certified by the manufacturer or is supervised by a representative of the manufacturer. The inspector should request to see the certification. The date on the certification must not be prior to the latest approved effective date for the device. A listing of the latest approved effective dates will be sent to each Project Engineer's Office when changes are made or can be requested from the Design Office.

8-11.4 Measurement and Payment

Measurement and Payment Instructions are covered in Sections 8-11.4 and 8-11.5 of the *Standard Specifications*.

8-12 Chain Link Fence and Wire Fence

8-12.1 General

Four types of chain link fences are provided in the *Standard Plans*. Type 1 and 6 are the highest quality fence with top rail and tension wire along the bottom of the fabric.

Two types of wire fence are provided in the *Standard Plans*. Type 1 is a combination of barbed wire and wire mesh. Type 2 consists of barbed wire. Steel or wood posts may be used with either type provided that only one material is used consistently throughout the job.

8-12.2 Clearing and Grading

Since preservation of natural growth is being stressed, clearing will have to be performed specifically for the fence construction on many projects. In these cases, only the width necessary to accommodate the fence construction should be cleared. Some grading is usually necessary to prevent short and abrupt breaks in the ground contour that will affect the aesthetic appearance of the top of the fence. Care needs to be exercised to prevent clogging natural drainage channels while grading the fence line.

8-12.3 Measurement and Payment

Measurement and payment instructions are covered in Sections 8-12.4 and 8-12.5 of the *Standard Specifications*.

8-14 Cement Concrete Sidewalks

8-14.1 General

Air entrained concrete Class 3000 (or Commercial Concrete) shall be used for construction of sidewalks. Forms may be of wood or metal and full depth of the sidewalk. The forms should be straight or uniformly curved and in good condition.

In rest areas and park areas where the sidewalks are normally laid out in a winding pattern rather than in straight lines, care must be taken in setting the forms so that the sidewalk will present a pleasing appearance with no kinks or angle breaks. The forms must be braced and staked sufficiently to maintain them to grade and alignment. Usually, spreaders are necessary to properly space the forms and hold them in position until the concrete is placed. If the Contractor uses thin strips of form material for winding sidewalks, more than one thickness with staggered joints should be used to obtain the smooth flowing lines. In forested areas, all roots should be removed or cut back.

After the forms have been set, the foundation shall be brought to the required grade, compacted and well dampened. Prior to placement of concrete, the inspector shall verify that the forms are set to line and grade, and shall check the forms for cross-slope and grade of the sidewalks and ramps, for conformance with the Plans, and to ensure that the requirements of the Americans with Disabilities Act (ADA) are met. If there are junction boxes, cable vaults, manholes or other utilities present in the sidewalk or ramp surface, they must be flush with the sidewalk or ramp surface.

8-14.2 Placing, Finishing, and Curing Concrete

After the concrete is placed, it should be struck off with a heavy iron-shod straightedge. The concrete should be troweled smooth with a steel trowel and then lightly brushed in a transverse direction with a soft brush. On grades of over 4 percent, the surface shall be finished with a stipple brush or as the Engineer may direct. Following brushing of the surface, the concrete shall be edged and jointed as shown in the plans or the *Standard Plans*. In areas adjacent to existing sidewalks, the jointing pattern should be similar to the existing pattern. Consideration should be given to placing crack control joints adjacent to cracks in the existing sidewalk if they are not going to be repaired. If the cracks in the existing sidewalk are full depth, they may cause reflective cracking in the new adjacent sidewalk.

Expansion joints shall be constructed at the locations and of the sizes as detailed in the plans or in the *Standard Plans*.

All concrete sidewalks shall be properly cured. During this curing period, all traffic, both pedestrian and vehicular, shall be excluded. Vehicular traffic should be discouraged and by no means allowed until the concrete has reached its design strength. There is a risk that the sidewalk can be damaged as it was not designed to take these loads. Before any decision to allow vehicles on a sidewalk there should be a clear agreement that any damage will be repaired and who will pay for it.

8-14.4 Measurement and Payment

Measurement and payment instructions are covered in Sections 8-14.4 and 8-14.5 of the *Standard Specifications*.

8-20 Illumination, Traffic Signal Systems, and Electrical

8-20.1 General

Illumination and traffic signal systems, due to the very nature of the work, are a highly specialized type of installation. In designing these systems, every effort is made to avoid problems for construction, maintenance, and the utility company. If problems arise, the Engineer should contact those responsible for the design and operations for help in solving them.

8-20.2 Materials

8-20.2A Approval of Source

All materials for installation on illumination and traffic signal projects shall be selected off the *Qualified Products List* (QPL) or be listed on a Request for Approval of Material (RAM). Items not selected off the QPL shall be submitted to the State Materials Laboratory for

appropriate action on a RAM. This list shall be complete and cover all materials which are identified on the plans or in the specifications. The list shall include the source of supply, name of manufacturer, size and catalog number of the units, and shall be supplemented by such other data as may be required including catalog cuts, detailed scale drawings, wiring diagrams of any nonstandard or special equipment. All supplemental data shall be submitted in six copies.

The Record of Materials (ROM) from the State Materials laboratory will list items for which preliminary samples or data are required. Preliminary and acceptance samples shall be submitted as required by the ROM, received from the State Materials Laboratory at the beginning of the project or as noted on the RAM. See Section 9-4 for material specific acceptance requirements.

8-20.2B Shop Drawings for Illumination and Signal Standards

The Contractor is required to submit shop drawings for all types of signal standards and for light standards without pre-approved plans. Pre-approved plans are listed in the Contract Provisions. If light standards with pre-approved plans are proposed, no shop drawing submittal is required. There are two different approval procedures for shop drawings. They are the State Bridge and Structures office approval, and Project Engineer approval only. In either case, the Contractor is required to submit six sets of drawings. The two approval procedures include the following:

A. Bridge and Structures Office Approval

- Light standards without pre-approved plans.
- Types II, III, IV, V signal standards without pre-approved plans.
- Type SD (Special Design) signal standards.

B. Project Engineer Approval Only

- Types PPB, PS, I, RM and FB signal standards, *Standard Plan* J-7a.
- Types II, III, IV, V signal standards with pre-approved plans.

After the Contractor has submitted shop drawings, the Engineer shall make a field check of both contract plans and shop drawings. The Project Engineer is responsible for checking the geometric features of these items. Specific items that should be checked include the following:

- Foundation locations.
- Light source to base dimension (H1), if required in the special provisions and clearance to overhead utility wires.
- Mast arm lengths. If foundation offsets are changed, mast arm lengths must be adjusted.
- Horizontal dimensions from single standard pole centerline to signal head attachment points.
- Vertical dimensions from signal standard base plate to signal mast arm connection points. Assistance is available from the Traffic Design office in estimating mast arm deflection to ensure vertical clearance requirements are met.
- Orientations of mast arms and all pole-mounted appurtenances.
- Signal head mounting details.
- Hand hole location and orientation.
- Base treatment for lighting standards (fixed, or slip, or breakaway).

If there are no changes to dimensions or orientations, the Project Engineer shall mark the drawings with a statement that all standards shall be fabricated according to dimensions and orientations shown in the Contract.

If there are corrections, the Project Engineer shall note all corrections on one set of shop drawings, with green markings only, and attach copies of signal standard chart and/or luminaire schedule from contract, noting any dimension changes in green. Transmittal Letter, Form 410-025, shall be used to submit the entire package.

The State Bridge and Structures office will conduct a structural review, and mark all sets in red, incorporating the Project Engineer's geometric review comments.

The six sets of shop drawings for supports without pre-approval shall be submitted to the State Bridge and Structures office, which will coordinate approval with the State Materials Laboratory. After approval, the State Bridge and Structures office will retain one set and forward two sets to the State Materials Engineer and send three sets to the Project Engineer. One of the State Materials Engineer's sets will be forwarded to the Fabrication Inspector. The Project Engineer will send two sets to the Contractor, who will forward one set to the Fabricator. See the Shop Plans and Working Drawings Table in Chapter 1-2.4H of this manual.

If pre-approved shop plans have been submitted, a structural review by the State Bridge and Structures office is not required. The Project Engineer shall mark all changes in red on all six copies. The Project Engineer will then retain one set of plans, forward one set to the Regional Operations/ Construction Engineer, two sets to the Fabrication Inspector, and two sets to the Contractor, who will forward one set to the Fabricator. See the Shop Plans and Working Drawings Table in Chapter 1-2.4H of this manual.

All drawings shall be clearly marked ("Approved as Noted", "Returned for Correction", or "Approved") before returned to the Contractor, whether reviewed and checked by the Project Engineer or the Bridge and Structures Office.

8-20.3 Relations With the Serving Utility

Generally, during the design of an illumination or traffic signal system, the serving utility is consulted concerning the availability of power, the voltage needed, the location of the most convenient point of service, and agreements are prepared prior to the awarding of the contract. The Project Engineer should review all utility agreements and contact the serving utility as soon as the Contractor commences work to arrange for the actual service connections and other work which may have been agreed upon. The matter is important since, in many cases, the utility will have to extend lines, install transformers, and do other related work. Upon completion of the contract, the Project Engineer will instruct the serving utility to direct all future billings to the appropriate maintenance division.

8-20.4 Inspection

Inspection on electrical projects involves two aspects of work. The first of these is the physical aspect wherein conformance to the plan requirements relative to the materials used and general construction techniques must be the criterion for judgment. An Inspector who is thoroughly familiar with the requirements of Section 8-20 of the *Standard Specifications* and with normal construction techniques should be assigned the inspection responsibility for this portion of any signal or illumination project. The Fabrication Inspector shall be consulted if lighting or traffic signal standards arrive on the jobsite without prior inspection.

The second aspect of electrical work involves the conformance by the Contractor with the contract requirements in addition to the requirements of the State electrical construction codes and the National Electric Code. This aspect of inspection must be performed by an electrical Inspector. A further consideration within this aspect of work involves any changes authorized in the contract plans as it may affect circuit stability, circuit adequacy, and the ability of related electrical control devices to properly function through any such change of plans. The performance testing of the system is part of the second aspect of the electrical work.

Electrical work is a specialized field of endeavor within WSDOT; therefore the Project Engineer must arrange for the assistance of an electrical Inspector from the Regional office. The electrical Inspector shall make periodic inspections throughout the course of construction of all electrical projects and shall advise the Project Engineer of appropriate times to enable the Project Engineer to occasion the required field tests of electrical circuits, as discussed in Section 8-20 of the *Standard Specifications*, at such times that cause a minimum interference of the work scheduled by the Contractor. Should any question arise on a project pertaining to the technical nature of the work, the Project Engineer shall consult with the electrical Inspector or with the Regional Traffic Engineer, if necessary.

Our plans and specifications are designed generally to conform with existing national electrical codes. There are instances when the Department permits methods of construction that are considered equivalent to state and national codes.

Generally, local inspection authorities do not inspect highway work that is within the state highway right of way. From time to time, however, the Department of Labor and Industries or local electrical inspectors may visit a project to inspect or review the Contractor's work. They should be treated courteously and their judgment respected. The Department does have authority to permit alternate methods when equivalent objectives can be met if the work is within the State right of way. Should any question arise over a conflict between our plans and their opinions, the matter should be referred to the State Construction Office for advice.

8-20.5 As-Built Plans

The Project Engineer is required to submit As-Built Plans in accordance with Chapter 10-3.7 of this manual. For proper maintenance and repair of the electrical system, it is imperative that the location of all conduits and the diagram of all circuits be properly shown on the As-Built Plans.

Normally, the conduits should be constructed in the locations shown on the contract plans. Many times these conduits are positioned in a particular place to eliminate conflict with future construction.

Section 8-20.3(17) of the *Standard Specifications* requires the Contractor to submit any corrected shop drawings, schematic circuit diagrams or other drawings necessary to prepare the corrected as-built plans.

8-20.6 Construction

8-20.6A Foundations

The foundations shall be located and constructed as detailed on the plans wherever possible. When foundations cannot be constructed as detailed, due to rock, bridge footings, drainage structures, or other obstructions, an effective foundation will have to be developed for the conditions encountered and approval obtained. The location of lighting standards or signal standards shall not be moved without discussing the problem with the Regional Operations/Construction Engineer and the Regional Traffic Engineer.

Foundations located on fills, especially those adjacent to bridge abutments, shall be deepened to provide stability as provided for in Section 8-20.3(4) of the *Standard Specifications*.

8-20.6B Conduit

Generally, conduit runs should be located on the outer shoulder areas, well away from the position where signs, delineators, guardrails and other facilities will be placed.

On new construction, all conduit located under paved surfaces shall be placed prior to construction of base course and pavement. It shall be the responsibility of the Project Engineer to see that all contractors on any project coordinate their work to this end.

Sufficient cover must be provided to protect the conduit from damage as provided in Section 8-20.3(5) of the *Standard Specifications*.

At locations where plastic conduit is allowed and hard rock is encountered within the minimum depth required, steel conduit should be substituted for the affected runs, and the depth adjusted as necessary.

8-20.6C Junction Boxes

In most designs, precast concrete junction boxes are being used. These boxes are simple to install. A sump is excavated and partially filled with gravel. The open-bottom box is then seated by working it into the gravel until the required grade is reached. Care must be taken in junction box location to provide for drainage. Junction boxes and conduit should be placed away from areas that water is funneled to prevent it from entering into the conduits. For example, the bottom of ditches, sag vertical curves should be avoided or other low spots where water is likely to collect.

8-20.6D Wiring

An electrical system is only as good as its conductors, terminals and splices, and it is important that the requirements of Section 8-20.3(8) of the *Standard Specifications* be strictly adhered to. If there is any doubt concerning the adequacy of a connector, the advice of the Regional Electrical Inspector should be obtained.

Practically all wiring for traffic signal and illumination systems is exposed to the elements, and it is very important that all splices be insulated with waterproof material, as prescribed in Section 8-20.3(8) and 9-29.12 of the *Standard Specifications*.

8-20.6E Ground

Because of the hazards of electrical shock, all grounds and ground bonds referred to in the plans and in the special provisions should be given special attention to ensure their effectiveness and completeness. See *Standard Specifications* Section 8-20.3(9) and *Standard Plan* J-9a.

8-20.6F Lighting Standards, Strain Poles

In erecting lighting standards or signal standards, rope or fabric slings should be used to reduce the danger of damage to galvanized or finished aluminum surfaces.

8-20.6G Existing Illumination Systems

Where existing illumination or traffic signal systems are to be removed, and the material stockpiled at the site of the work for delivery to WSDOT, it will be advantageous if prior arrangements are made to have Department personnel meet the contractor at the delivery storage site. These arrangements should be made with either the Regional Maintenance Engineer or the Regional Traffic Engineer.

8-20.6H Service Equipment

Generally, Type “B”, “C”, “D”, and “E” service equipment, cabinets etc., will be factory assembled from drawings submitted with the material lists. Type “A” service equipment will be assembled in the field. Care shall be taken to ensure compliance with all provisions of the plans and specifications, and to determine that all bonds and grounds are complete.

8-20.6I Traffic Signal Systems

Traffic signal systems are a very specialized type of work. All work shall be done in strict accordance with the plans, the special provisions, and the *Standard Specifications*. The Regional Traffic Engineer will be responsible for the proper timing of each signal installation and will assist the Engineer in any way needed to ensure the proper completion of the work. The checklist (Figure 8-1) is provided to assist the Project Engineer in identifying the specific tasks that must be completed prior to signal turn-on. This checklist is a guide, and line items may be added or deleted as necessary to fit each specific signal installation.

Contract # _____ Location _____

Project Engineer _____ Date _____

Proposed* turn-on date _____ Proposed* test date _____

Point of contact _____ Phone # _____

This checklist highlights the critical items of work that are to be complete before the signal system can be placed into operation.
*The Project Engineer has the authority to reschedule the test date or signal turn-on at their discretion.

	SIGNING:	Applicable to project	Complete
1.	Advance warning “Signal Ahead/W3-3” signs (permanent)		
2.	“New Signal” or “Signal Revision” signs (temporary)		
3.	“Left Turn Must Yield on Green Ball” sign		
4.	Lane control signs		
5.	Street name signs		
	STRIPING (Installed or scheduled):	Applicable to project	Complete
6.	Stop Bar(s)		
7.	Crosswalk stripes		
8.	Channelization		
9.	Channelization aligns with signal heads		
	SIGNAL DISPLAY SYSTEM:	Applicable to project	Complete
10.	All vehicle displays are connected and tested		
11.	All pedestrian displays are connected and tested		
12.	Restrictive left turn display is over left turn lane		
13.	Combination of restrictive/permissive left turn display is over the gore stripe.		
14.	Optically programmed displays are properly programmed for the intended movement.		
15.	Vertical clearances are met.		
	SIGNAL DETECTION SYSTEM:	Applicable to project	Complete
16.	All vehicle detection (temporary and permanent) is tested.		
17.	If staging is required, all side street stop bar detection is tested as a minimum for semi actuated operation.		
18.	All pedestrian detection (push buttons) are tested.		
19.	All emergency vehicle preemption detection are tested.		
20.	Railroad preemption is tested.		
	SIGNAL CONTROL SYSTEM:	Applicable to project	Complete
21.	Controller is tested and available		
22.	Cabinet is installed, wired and ready for controller hookup.		
23.	Interconnect is tested.		
24.	Permanent power source is supplied to the system.		
	CONTRACTOR CONTACT RESPONSIBILITIES:	Applicable to project	Complete
25.	Controller manufacturer representative (not required if state supplied controller)		
26.	Uniformed Police/State Patrol for Traffic Control		
	ELECTRICAL INSPECTOR CONTACT RESPONSIBILITIES (Five (5) days prior to proposed* signal test date):	Applicable to project	Complete
27.	Signal Maintenance		
28.	Signal Operations		
	PROJECT ENGINEER CONTACT RESPONSIBILITIES (Five (5) days prior to proposed* signal test date):	Applicable to project	Complete
29.	Local Agencies (City, County, State Patrol, Fire District, etc.)		

COMMENTS:

Traffic Signal Turn-on Checklist Revised 1/10/00
Figure 8-1

8-20.6J Testing

All illumination and traffic signal systems shall be tested as outlined in Sections 8-20.3(11) and 8-20.3(14)D of the *Standard Specifications*. Particular care shall be taken in the performance of test no. 3. The Project Engineer shall insure that readings of the megohmmeter taken on every electrical circuit are furnished to the Regional Electrical Inspector. Caution must be exercised in the performance of this test to protect control mechanisms from damage due to the nature of the test voltages used. Also, the records made of this series of tests must identify the readings observed with each branch of the electrical circuit involved. Representative sampling of the Contractor's test readings may be made by the Electrical Inspector using State test equipment.

Field Test No. 4 of Section 8-20.3(11) of the *Standard Specifications* is to be performed on all illumination and signal projects. It is especially important that the Project Engineer obtain the consultation of the Regional Traffic Engineer in this portion of the field test when the tests are being performed in a traffic signal controller. Since the mechanism in these controllers is so interrelated and complex, only persons thoroughly schooled in such control mechanisms are qualified to determine when particular timing circuits and sequences are functioning properly. The simple turning on of an electrical switch and watching a light come on is not an acceptable electrical test.

8-20.6K Electrical Safety Tags

Commencing at the time that the serving utility makes the power drop to WSDOT electrical service cabinets, electrical safety tags shall be used. Any electrician working on any main or branch circuit shall cause that circuit to be de-energized and shall place an electrical safety tag at the point that the circuit is open. The electrician shall sign the electrical safety tag and only that electrician may make subsequent circuit alterations or remove the tag.

If the circuit that the electrician de-energized to work on is serving traffic, the electrician shall arrange the work so the circuit may be energized for nighttime operation. The electrician shall remove the safety tag and energize the circuit before leaving the jobsite and upon returning to work on the circuit, shall de-energize it again and place an electrical safety tag back on the circuit.

8-20.7 Prevention of Corrosion of Conduit

Installation of conduit should be supervised to ensure against physical abrasion of the conduit or for rust on threads which would destroy the integrity of the galvanizing.

Electrically caused corrosion of metallic conduit is easy to avoid by proper construction supervision. If the causes of this type of corrosion are not properly inspected and controlled, the extent of electrically caused corrosion is commonly far more severe than the chemically caused corrosion.

In any metallic conduit system, the metallic conduit itself serves an electrical function. This function is to provide a low resistance return path for electricity which may leak out of an electrical conductor due to scraped insulation, cracks, or other causes. A point at which electricity can leak or escape from an electrical wire is called a "fault".

When electricity flows through any non-insulated path (conduit), it can establish an electrical phenomenon called electrolysis. Electrolysis results in the transfer of metal from one location to metal at another location. Through this means, the metal that was used to make the metallic conduit may be transferred to other locations on the same conduit run or to other metallic appurtenances. With the ultimate degeneration of conduit at any point, the return path for the electricity through the conduit system itself is destroyed. In the event that a portion of a conduit was destroyed in this means and with the subsequent damage or failure of electrical conductors beyond that point, electricity would not have the ability to complete the circuit from the wire through the conduit system and return to service enclosure which would, in turn, cause a fuse to blow or a circuit breaker to trip. Hence, the protection offered by our electrical overload equipment is totally nullified.

To prevent this type of ultimate failure of the electrical system, all conduit joints should be carefully inspected to ensure that they are physically tight and that a good electrical bond does exist from one piece of conduit through the nipple to each adjoining piece of conduit. Additionally, conduit threads should be painted with an approved corrosion inhibiting conduit paint. Any loose or improper union between conduit sections or conduit and junction boxes is a point of high resistance to the flow of electricity. When such a condition exists and with the faulting of an electrical conductor within the system, electricity does not have an easy return to its point of service. Electricity then takes alternate routes through the earth, structures, etc. This, in particular, establishes the condition of electrolysis and results in even greater failure of the physical system. The physical system failure attributed to this may present itself from two to five years after construction.

The seriousness of this matter cannot be overstressed in electrical construction. It is so important that if one factor, and only one factor, was to be examined on each electrical project, it would be the search for conditions that would result in electrolysis and the sloppy workmanship that causes them.

Additionally, to prevent electrical damage to the conduit system and, in particular, during the time of project construction, the conduit shall not be used as a temporary neutral return nor shall the conduit be used for the ground of construction equipment, i.e., welders, hand tools, etc.

8-20.8 Measurement and Payment

Measurement and Payment instructions are covered in Sections 8-20.4 and 8-20.5 of the *Standard Specifications*.

8-21 Permanent Signing

8-21.1 General

The complex design of today's freeway facilities has created an increased demand on signing. Signing is one of the features a layperson readily can evaluate on a new facility. Improper or inadequate signing detracts from the quality of the basic construction features of the project. Misplaced or irregular usage of signs on interchanges creates a critical hazard to traffic and hinders the proper operation of the facility.

Today's destination sign has increased in size to the extent that it is no longer a minor installation and the amount of time required to install an average freeway sign project has been extended to the point that close cooperation between all forces on highway construction projects is vital so that the facility is signed properly when opened to traffic.

Any sign that is erected on a section of roadway carrying traffic ahead of the time the message on the sign will be applicable to the traffic shall be covered in accordance with Section 8-21.3(3) of the *Standard Specifications* until the appropriate time for uncovering it. It is essential that signs with conflicting messages not be displayed.

8-21.2 Sign Location

Since it is impossible to visualize the actual physical features of final grade elevations, vertical curves, trees, and other factors that affect proper sign placement in the initial sign plan stage, it becomes necessary to make adjustments in sign location just prior to installation. The Project Engineer and Regional Traffic Engineer should coordinate a study of each location to determine that each sign will be in the most efficient location for visibility and nighttime reflectivity. Advance Destination signs may be moved up to 500 feet (150 meters) in either direction if severe ground or slope conditions are encountered. If the sign must be moved more than 500 feet (150 meters), consideration should be given to revising the distance on the sign. All sign locations shall be staked by the Engineer prior to installation by the Contractor.

Following staking of the signs, the Project Engineer should furnish the Contractor with the list of post lengths for steel posts. For wooden posts, the Contractor should be able to order posts in commercial lengths from the approximate lengths shown in the plans. Final lengths of timber posts will be determined or verified by the Engineer at the request of the Contractor prior to fabrication.

Anytime an existing bridge mounted sign bracket, cantilever sign structure, or sign bridge structure is removed from service, the Contractor shall remove any existing sign structure identification plate and give it to the Project Engineer. The Project Engineer will return the identification plate to the State Bridge Preservation Office so the sign structure can be removed from the inventory.

8-21.3 Approval of Materials

All materials for installation on permanent signing projects should be selected off the *Qualified Products List* (QPL) or listed on the Request for Approval of Materials (RAM). Materials listed on RAM not listed on the QPL shall be submitted to the State Materials Laboratory for appropriate action as soon as possible. Shop drawings of sign structures shall be reviewed by the Project Engineer for conformance with the *Standard Plans* Section G. The Project Engineer approves plans in conformance with the standard plans. Any request to deviate from standard plans should be reviewed by the State Bridge and Structures Office.

The eight sets of shop drawings of special design sign structures and/or special sign fittings shall be submitted to the State Bridge and Structures office, which will coordinate approval with the State Materials Laboratory. After approval, the State Bridge and Structures office will retain one set and forward two sets to the State Materials Engineer and send three sets to the Project Engineer. One of the State Materials Engineer's sets will be forwarded to the Fabrication Inspector. The Project Engineer will send two sets to the Contractor, who will forward one set to the Fabricator.

If a structural review is not required by the State Bridge and Structures office, the Project Engineer shall mark all changes in red on all eight copies and distribute per the Shop Plans and Working Drawings Table in Chapter 1-2.4H of this manual.

All drawings shall be clearly marked ("Approved as Noted", "Returned for Correction", or "Approved") before returned to the Contractor, whether reviewed and checked by the Project Engineer or the State Bridge and Structures Office.

The special provisions of the contract deal to a great extent with the proper fabrication of the signs to be installed and the manufacturing process requiring the use of approved application equipment. It is necessary, therefore, that the firm who actually makes the signs be approved as a source of supply. Such approval is made by the State Materials Laboratory.

8-21.4 Inspection

A "fabrication approval" decal dated and signed by the Sign Fabrication Inspector shall appear on the back of all permanent signs that are received on the project. Signs without such indicated approval shall not be permitted on the project. Damaged signs shall be rejected at the project site.

At the completion of a sign installation, the Project Engineer shall request the Regional Traffic Engineer to assist in making a final inspection.

8-21.5 Bolting Base Connections

It is important to ensure the proper torque is applied to bolts connecting the bases when installing *Standard Plan* G-24.10.00 through G-24.60.00 Sign Structures. Procedures for assembling and inspecting high strength bolts are covered in Chapter 6-3.6B of this manual. All base assemblies shall be checked with a torque wrench. This can be accomplished either by observing the Contractor's torquing or by the Inspector utilizing the Region's torque wrench. Documentation of the torquing method used should be accomplished by proper entries in the Inspector's Daily Reports.

8-21.6 Measurement and Payment

Measurement and Payment instructions are covered in Sections 8-21.4 and 8-21.5 of the *Standard Specifications*.